Pterorytis pacanana new species (Gastropoda: Muricidae): circumstantial evidence for late Pliocene El Niño events in southern Peru

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ABSTRACT

Pterorytis pacanana new species was discovered in upper Pliocene bioclastic sandstone near Chala, southern Peru. Although it was found farther south than other *Pterorytis* species from the eastern equatorial Pacific Ocean, *P. pacanana* most resembles *P. roxaneae* Petuch, 1994, from the Pliocene Pinecrest beds of Florida. Its presence among endemic late Pliocene cool-water mollusks from high-energy shoreface paleoenvironments is thermally anomalous in the same sense as the rare occurrence of other species from northern Peru and Ecuador in upper Pliocene and Pleistocene strata from southern Peru. By analogy with modern thermally anomalous mollusks that appear episodically off the coast of southern Peru and Chile, the Pliocene and Pleistocene examples are circumstantial evidence for the occasional southward incursion of warm equatorial waters during former El Niño events.

INTRODUCTION

Pliocene deposits in southern Peru are noted for a variety of muricid gastropods, most belonging to genera still represented by extant species (e.g., *Acanthina* Fischer von Waldheim, 1807; *Chorus* Gray, 1847; *Concholepas* Lamarck, 1801; *Crassilabrum* Jousseaume, 1880; *Muregina* Vermeij, 1998; *Stramonita* Schumacher, 1817; *Xanthochorus* Fischer, 1884), but some from genera entirely or locally extinct (e.g., *Herminespina* DeVries and Vermeij, 1997; *Trophon*, Montfort, 1810) (DeVries, 1995, 1997, 2000, 2003, in press a, in press b; DeVries and Vermeij, 1997). Specimens of most Pliocene muricids are not exceedingly difficult to find.

A well-preserved muricid from Pliocene bioclastic sandstone south of Chala is, literally, the rare exception. None have been found other than a single shell plucked from a roadcut of the Panamerican Highway that overlooks Playa Huacllaco. The lamellar fimbriate varices of the Huacllaco specimen invite comparison with ocenebrines from Ecuador, the southeastern United States, and the northwestern Pacific Ocean. Its lone appearance in a collection of endemic cool-water muricids is another example of a thermally anomalous molluscan species encountered in upper Pliocene and Pleistocene beds of southern Peru (Muizon and DeVries, 1985; DeVries, 1986; Ortlieb et al., 1990). A reasonable hypothesis is that these equatorial species were introduced to higher austral latitudes by warm-water incursions during the Pliocene and Pleistocene comparable to modern incursions that carry Panamic molluscan larvae poleward during El Niño events (DeVries, 1988; Arntz and Tarazona, 1990; Paredes et al., 1998).

GEOLOGY

Bioclastic sandstone and gravel and balanid coquina overlie igneous basement in roadcuts along a series of sweeping curves in the Panamerican Highway where it descends towards the beach at Playa Huacllaco (Figure 1). The sediments represent high-energy foreshore and intertidal paleoenvironments that once flanked steep cliffs. The section, previously published

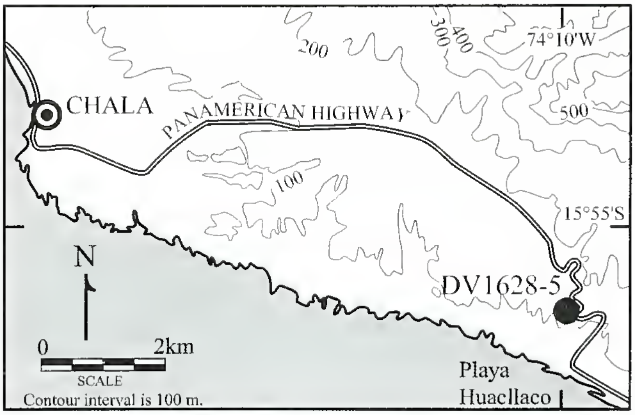

Figure 1. Type locality of *Pterorytis pacanana* new species (DV 1628).

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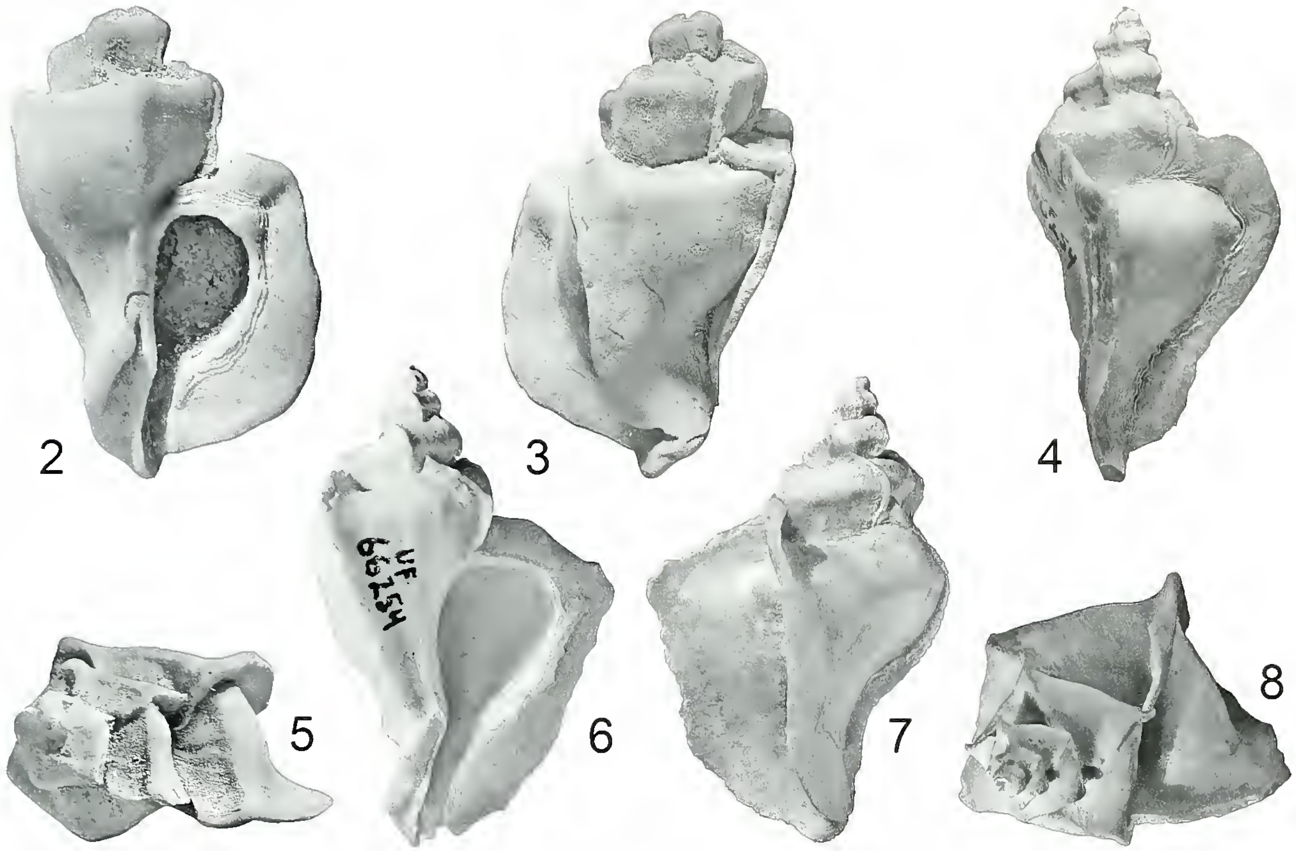

Figures 2–8. *Pterorytis* species. **2, 3, 5.** *Pterorytis pacanana* new species. Upper Pliocene. Holotype, UWBM 97772, length = 30.9 mm, width = 19.6 mm. **2.** Apertural view. **3.** Abapertural view. **5.** Oblique view of spire. **4, 6–8.** *Pterorytis roxaneae* Petuch, 1994. Upper Pliocene. Holotype, Florida Museum of Natural History, Gainesville, UF 66254, length = 33.3 mm, width = 21.5 mm. **4.** Lateral view. **6.** Apertural view. **7.** Abapertural view. **8.** Oblique view of spire.

by DeVries (2003), consists of four stratigraphic units. The ocenebrine specimen was found at the base of Unit III, just below strata where rounded clasts of blackened andesite first appear in great numbers and below beds where specimens of *Concholepas* and *Acanthina* acquire their modern form (DeVries, 2000, 2003).

The age of the Huaellaco beds is bracketed by basal beds with specimens of *Concholepas nodosa* Hupé, 1854, *Acanthina triangularis* DeVries, 2003, and *Herminespina mirabilis* (Möricke, 1896), which collectively indicate an early late Pliocene age (DeVries and Frassinetti, 2003), and the uppermost and oldest of several marine terraces, whose elevation and largely extant taxa suggest a latest Pliocene age (Muizon and DeVries, 1985).

MATERIALS AND METHODS

The specimen from Peru described in this study was found by the author. Dimensions affected by breakage are enclosed by parentheses. The holotype is deposited at the University of Washington's Burke Museum of Natural History and Culture in Seattle, Washington (UWBM).

SYSTEMATICS

Family Muricidae Rafinesque, 1815
Subfamily Ocenebrinae Cossmann, 1903
Genus *Pterorytis* Conrad, 1862
Subgenus *Pterorytis* sensu stricto

Type Species: *Murex umbrifer* Conrad, 1832, by monotypy.

Pterorytis pacanana new species
(Figures 2, 3, 5)

Diagnosis: Shell small; texture waxy, shell thin. Five lamellar, fimbriate varices; intervarical nodes absent. Three spiral cords; shoulder spiral cord strong. Sutural platform horizontal. Labral tooth absent.

Description: Shell 30.9 mm long (first teleoconch whorls missing), quadrate in profile, very thin, with waxy texture. Spire estimated to be about 40 percent of shell length. Siphonal canal about 20–25 percent of shell length. Protoconch and earliest teleoconch whorls missing. Upper sides of whorls planar, vertical; base of body whorl sharply constricted. Shoulder orthogonally angulate, sutures deeply impressed; sutural platform horizontal to slightly concave. Three last whorls with five lamellar varices extending from fasciolar ridge to suture, each varix joining across suture with varix of previous whorl. Lamellae broader basally, narrower adapically, extended adapically at shoulder but not spinose; fimbriate on adapertural face; erect or recurved adaperturally except apertural lamellae, which is weakly recurved abaperturally. Intervarical nodes absent. Spiral sculpture of prominent but ill-defined rounded primary cord at shoulder angulation and two additional broad low spiral cords anteriorly, almost obsolete. Additional broad low secondary cords barely visible adjacent to adapertural face of varices. Lamellar fimbria slightly extended at intersection with primary spiral cords. Aperture with inverted tear-drop shape. Parietal rib, anal sulcus absent; parietal area unexcavated. Columella smooth, inner lip very weakly concave, adherent anteriorly. Outer lip without dentition on inner edge. Labral tooth absent. Siphonal canal open, slightly recurved to right. Siphonal fasciole strongly arched, without rostrae. Pseudo-umbilicus narrow, extending adapically beyond siphonal canal.

Holotype: UWBM 97772, DV 1628-5, lower Upper Pliocene, length (30.9) mm, width 19.6 mm.

Type Locality: Roadcut along the Panamerican Highway, 10 km south of Chala, on a winding descent from a 200 m elevation terrace towards Playa Huacllaco, locality DV 1628, north side of first sweeping outside curve from base of outcrop, south side of road, near outcrop of igneous basement rock (Figure 1), 15°52′ S, 74°10′ W (Chala 1:100,000 quadrangle).

Occurrence: Upper Pliocene, southern Peru.

Etymology: 'Paca,' Quechua for 'high,' and 'nan,' Quechua for 'path,' referring to the horizontal to concave sutural platform bordered above and below by vertical walls of the whorls.

Remarks: *Pterorytis* or *Ocinebrellus* Jousseaume, 1880, is the most appropriate genus in which to place the Huacllaco specimen, which has five varices on at least the last three whorls, consistent with the three to nine varices observed on fossil Atlantic species of *Pterorytis* (Emerson, 1959; Vermeij, 2001), the four to five varices on the modern eastern Pacific *Pterorytis hamatus* (Hinds, 1844) (Emerson, 1985), and three to twelve varices on specimens of *Ocinebrellus* (Amano and Vermeij, 1998a). The ocenebrine genera *Ceratostoma* Herrmannsen, 1846, *Pteropurpura* Jousseaume, 1880, and *Microrhytis* Emerson, 1959, in contrast, have three prominent lamellar varices on all or at least the last two whorls (Vermeij and Vokes, 1997; Amano and Vermeij, 1998a, 1998b). Specimens of *Ceratostoma*, *Pteropurpura*, *Microrhytis*, and some *Ocenebra* Gray, 1847, also have intervarical nodes, which are absent on the Huacllaco specimen and specimens of *Pterorytis* and *Ocinebrellus*.

The absence of a closed siphonal canal does not argue against assignment of the single Huacllaco specimen to *Pterorytis* or *Ocinebrellus*, since juvenile and some adult specimens of the two genera may have an open siphonal canal. The Peruvian specimen, itself partly abraded, might be a juvenile specimen or have a broken siphonal canal.

Distinguishing *Pterorytis* from *Ocinebrellus* for placement of the Huacllaco specimen is problematic. *Ocinebrellus* has four primary spiral cords on the swollen portion of the body whorl, posterior to the labral tooth, if present (Vermeij and Vokes, 1997; Amano and Vermeij, 1998a). *Pterorytis* and the Huacllaco specimen have three primary spiral cords, with an additional weak primary spiral between the shoulder and suture. On smoother specimens of both genera the number of primary spiral cords can be difficult to enumerate, and on strongly sculptured specimens the distinction between primary and secondary spiral cords is unclear if the ontogeny is unknown.

Other features are equally unsatisfactory for distinguishing the two genera. The reflection of lamellar varices is not reliable, since the lamellae may be adaperturally reflected, or not, in *Ocinebrellus* (Amano and Vermeij, 1998a), abaperturally reflected or erect in *Pterorytis* (Vermeij and Vokes, 1997), and erect or reflected in either direction on the Huacllaco specimen. The angularity of the shoulder also fails as a distinguishing character. Most specimens of *Ocinebrellus* have an angulate shoulder and a horizontal sutural platform (as is the case for the Huacllaco specimen), but some have rounded shoulders. Most specimens of *Pterorytis* have broad, planar, steeply sloping sutural platforms, but some have narrower, less inclined sutural platforms more like those of typical *Ocinebrellus* and the Huacllaco specimen.

The presence or absence of a labral tooth is not diagnostic. Some ocenebrines acquire a labral tooth only in adulthood; the Huacllaco specimen might be a juvenile. Species of *Pterorytis* that normally have a tooth (*P. umbrifer* Conrad, 1832; *P. fluviana* Dall, 1890) have specimens lacking a tooth. Specimens of *P. roxaneae* Petuch, 1994, never have a labral tooth (Vermeij and Vokes, 1997). Species of *Ocinebrellus* (sensu Amano and Vermeij, 1998a) that normally lack a labral tooth have specimens with a tooth. (In the more restrictive classification of Houart and Sirenko (2003), species of *Ocinebrellus* do not have a labral tooth.)

Taking into account this taxonomic ambiguity, the Huacllaco specimen is assigned to *Pterorytis*. Species of *Pterorytis* (*P. umbrifer*, *P. fluviana*, *P. roxaneae*) typically have smooth-shelled variants such as the specimen from Huacllaco. Most specimens of *Pterorytis*, like the Huacllaco specimen, feature a prominent primary spiral cord at the shoulder, but nonetheless usually lack spines or angulations typically seen in specimens of *Ocinebrellus*.

Pliocene Ecuadorian specimens assigned to *Ocinebrellus* by Vokes (1988) are smooth, have a prominent shoulder spiral bordering an inclined sutural platform, and have varices that are only weakly angulate; they may be referred to *Pterorytis ecuadoria* (Olsson, 1964). They have a more fusiform profile and greater number of varices than the Huacllaco specimen.

The specimen of *Pterorytis pacanana* most closely resembles specimens of the Pliocene *Pterorytis* (*Pterorytis*) *roxaneae* Petuch, 1994, (Figures 4, 6–8) from the Pliocene Pinecrest beds of Florida (Vermeij and Vokes, 1997). Specimens of both species are thin with a waxy texture, have reduced spiral sculpture, and lack a labral tooth. Pinecrest specimens differ from the Huacllaco specimen in having four varices, not five, varical lamellae that are broader adapically, not abapically, and a weak peripheral spiral cord bordering a sloping sutural platform, rather than the strongly defined horizontal sutural platform of *P. pacanana*. Contrary to Vermeij and Vokes (1997), the holotype of *P. roxaneae* is neither excessively worn nor lacking the labral varix.

DISCUSSION

Pterorytis pacanana is the third or fourth species of *Pterorytis* recognized in the eastern Pacific Ocean, after *P. ecuadoria* (Pliocene, Ecuador), *P. hamatus* (Recent, northern Peru [Alamo and Valdivieso, 1997], a species with a protoconch unlike that of *Ocinebrellus* or any other ocenebrine [R. Houart, personal communication, 2005]), and an unnamed Recent ocenebrine from northern Peru (Radwin and D'Attilio, 1976). These taxa define an eastern tropical Pacific complement to a clade of *Pterorytis* species from the southeastern United States whose oldest members date to the late Miocene. *Ocinebrellus*, which may be endemic to the northwestern Pacific (Amano and Vermeij, 1998a; Houart and Sirenko, 2003), extends back to the Early or Middle Miocene. *Ocinebrellus* seems morphologically more similar to *Pterorytis* than other ocenebrine clades, but the trail of fossil species that might lead from Japanese *Ocinebrellus* to Panama and the Caribbean and beyond to Peruvian and Floridian *Pterorytis* has yet to be discovered (Amano and Vermeij, 1998a).

Table 1. Molluscan species associated with *Pterorytis pacanana*, new species, which was found at the base of Unit III of the Upper Pliocene beds above Playa Huacllaco, Peru. (* = Extinct).

Unit III+IV (younger)	
	Acanthina unicornis (Bruguière, 1789)
	Cancellaria buccinoides Sowerby, 1832
	Choromytilus chorus (Molina, 1782)
*	*Chorus grandis* (Philippi, 1887) / *C. giganteus* (Lesson, 1846)
*	*Concholepas camerata* DeVries, 2000
	Concholepas concholepas (Bruguière, 1789)
	Crassilabrum crassilabrum (Sowerby, 1834)
	Crepidula dilatata (Lamarck, 1822)
	Eurhomalea lenticularis (Sowerby, 1835)
	Glycymeris ovata (Broderip, 1843)
	Mesodesma donacium (Lamarck, 1818)
	Mulinia edulis (King, 1831)
	Oliva peruviana Lamarck, 1811
*	*Piscoacritia* new species
	Prisogaster niger (Wood, 1828)
	Sinum cymba (Menke, 1828)
	Xanthochorus cassidiformis (Blainville, 1832)
Unit I+II (older)	
*	*Acanthina triangularis* DeVries, 2003
*	Acmaeids
*	*Chlamys* cf. *C. vidali* (Philippi, 1887)
	Choromytilus chorus (Molina, 1782)
*	*Chorus grandis* (Philippi, 1887)
*	*Concholepas camerata* DeVries, 2000
*	*Concholepas nodosa* (Möricke, 1896)
	Fissurella spp.
*	*Herminespina mirabilis* (Möricke, 1896)
	Lithophaga sp.
*	*Piscoacritia collapsa* DeVries and Hess, 2004
*	*Stramonita* new species
*	*Tegula* (*Chlorostoma*) new species
	Xanthochorus buxeus (Broderip, 1833)
*	*Xanthochorus* new species

The specimen of *Pterorytis pacanana* from 16°S is remarkable for its singular occurrence and equatorial affinity. Associated taxa (Table 1) are entirely endemic or cool-water species that became prevalent after a provincial mid-Pliocene extinction that coincided with a global cooling event (Dowsett et al., 1996; DeVries, 2001). The rare appearance of *Pterorytis* in southern Peru resembles that of a mangrove bivalve, *Anadara* cf. *A. grandis* (Broderip and Sowerby, 1829), whose specimens are found in small numbers in uppermost Pliocene beds at 15°30′ S with cool-water species (Muizon and DeVries, 1985; DeVries, 1986). In a more recent example, specimens of *Chione broggi* (Pilsbry and Olsson, 1943) and *Cerithium stercusmuscarum* Valenciennes, 1833, both living today only as far south as the Sechura coastline of northern Peru (5°S) (Alamo and Valdivieso, 1997), are occasionally found in upper Pleistocene terrace deposits near San Juan de Marcona (15°20′S), Sacaco (15°30′S), and Ilo (17°40′S) (DeVries, 1986, 1988; Ortlieb et al., 1990). Ortlieb et al. (1990) proposed that the late Pleistocene thermally anomalous species were introduced southward from equatorial latitudes during El Niño events. Several such immigrations of equatorial mollusks have been documented during modern El Niños events (Arntz and Tarazona, 1990; Paredes et al., 1998). The rare Pliocene equatorial species in southern Peru were probably introduced in the same manner.

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LITERATURE CITED

Alamo, V. and V. Valdivieso. 1997. Lista sistematica de moluscos marinos del Perú. Instituto del Mar del Perú, Callao, 183 pp.

Amano, K. and G. J. Vermeij. 1998a. Taxonomy and evolution of the genus *Ocinebrellus* (Gastropoda: Muricidae) in Japan. Paleontological Research 2: 199–212.

Amano, K. and G. J. Vermeij. 1998b. Origin and biogeographic history of *Ceratostoma* (Gastropoda: Muricidae). Venus 57: 209–223.

Arntz, W. A. and J. Tarazona. 1990. Effects of El Niño 1982–1983 on benthos, fish, and fisheries off the South American Pacific coast. In: P. W. Glynn (ed.) Global ecological consequences of the 1982–1983 El Niño-Southern Oscillation. Elsevier: Amsterdam, pp. 323–360.

DeVries, T. J. 1986. The geology and paleontology of tablazos in northwest Peru. Doctoral dissertation, The Ohio State University: Columbus, 964 pp.

DeVries, T. J. 1988. A review of geological evidence for ancient El Niño activity in Peru. Journal of Geophysical Research (Oceans) 92(C13): 14,471–14,479.

DeVries, T. J. 1995. *Concholepas* Lamarck, 1801 (Neogastropoda: Muricoidea): A Neogene genus native to South America. The Veliger 38: 284–297.

DeVries, T. J. 1997. A review of the genus *Chorus* Gray, 1847 (Gastropoda: Muricidae) from western South America. Tulane Studies in Geology and Paleontology 30: 125–147.

DeVries, T. J. 2000. Two new Neogene species and the evolution of labral teeth in *Concholepas* Lamarck, 1801 (Neogastropoda: Muricoidea). The Veliger 43: 43–50.

DeVries, T. J. 2001. Contrasting patterns of Pliocene and Pleistocene extinctions of marine mollusks in western North and South America. Geological Society of America, Abstracts with Programs 33(3): A-35.

DeVries, T. J. 2003. *Acanthina* Fischer von Waldheim, 1807 (Gastropoda: Muricidae), an ocenebrine genus endemic to South America. The Veliger 46: 332–350.

DeVries, T. J. a. (In press). The Late Cenozoic history of *Xanthochorus* Fischer, 1884 (Gastropoda: Muricidae) in western South America. The Veliger.

DeVries, T. J. b. (In press). Late Cenozoic Muricidae from Peru: Seven new species and a biogeographic summary. The Veliger.

DeVries, T. J. and C. D. Frassinetti. 2003. Range extensions and biogeographic implications of Chilean Neogene mollusks found in Peru. Boletín del Museo de Historia Natural, Chile 52: 141–157.

DeVries, T. J. and G. J. Vermeij. 1997. *Herminespina*: New genus of Neogene muricid gastropod from Peru and Chile. Journal of Paleontology 71: 610–615.

Dowsett, H., J. Barron and R. Poore. 1996. Middle Pliocene sea surface temperatures: a global reconstruction. Marine Micropaleontology 27: 13–25.

Emerson, W. K. 1959. The gastropod genus *Pterorytis*. American Museum Novitates 1974: 1–8.

Emerson, W. K. 1985. *Murex hamatus* Hinds, 1844, a living West American species assigned to the Neogene paciphile genus, *Pterorytis* Conrad (Gastropoda: Muricidae). The Nautilus 99: 14–17.

Houart, R. and B. I. Sirenko. 2003. Review of the Recent species of *Ocenebra* Gray, 1847 and *Ocinebrellus* Jousseaume, 1880 in the northwest Pacific. Ruthenica 13: 53–74.

Muizon, C. de and T. J. DeVries. 1985. Geology and paleontology of the Pisco Formation in the area of Sacaco, Peru. Geologische Rundschau 74(3): 547–563.

Ortlieb, L., T. DeVries and A. Diaz. 1990. Ocurrencia de *Chione broggi* (Pilsbry and Olsson, 1943) (Pelecypoda) en depositos litorales Cuaternarios del sur del Perú: Implicaciones paleoceanográficas. Boletín de la Sociedad Geológica del Perú 81: 127–134.

Paredes, C., J. Tarazona, E. Canahuire, L. Romero, O. Cornejo and F. Cardozo. 1998. Presencia de moluscos tropicales de la provincia panameña en la costa central del Perú y su relación con los eventos "El Niño". Revista Peruana De Biología (Universidad Nacional Mayor De San Marcos) 5(2): 123–128.

Petuch, E. J. 1994. Atlas of Florida Fossil Shells. Chicago Spectrum Press, Evanston, 394 pp.

Radwin, G. E. and A. D'Attilio. 1976. Murex Shells of the World. Stanford University Press, Stanford, 284 pp.

Vermeij, G. J. 2001. Innovation and evolution at the edge: origins and fates of gastropods with a labral tooth. Biological Journal of the Linnean Society 72: 461–508.

Vermeij, G. J. and E. H. Vokes. 1997. Cenozoic Muricidae of the western Atlantic region. Part XII - the subfamily Ocenebrinae (in part). Tulane Studies in Geology and Paleontology 29: 69–118.

Vokes, E. H. 1988. Muricidae (Mollusca: Gastropoda) of the Esmeraldas beds, northwestern Ecuador. Tulane Studies in Geology and Paleontology 21: 1–50.